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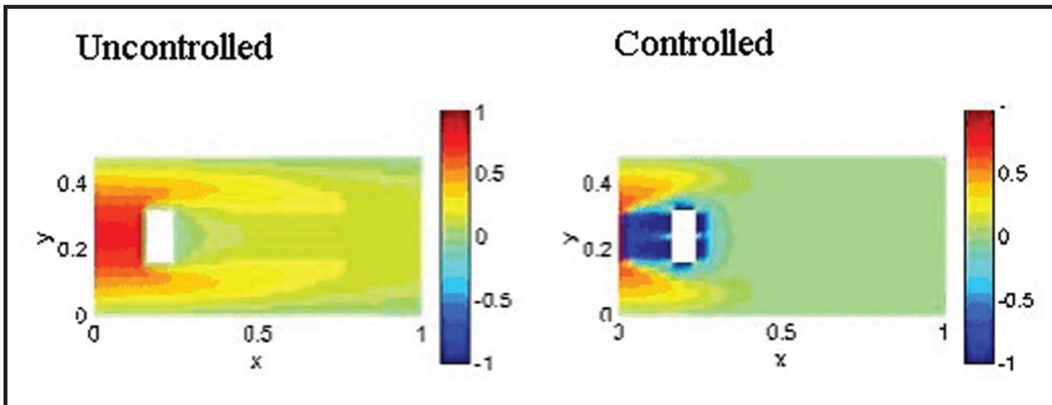
Science and Technology for Tomorrow's Air and Space Force

Success Story

CONTROL OF DISTRIBUTED PARAMETER SYSTEMS FOR AERODYNAMIC FLOWS



Air Vehicles Directorate scientists have taken the first step in developing a more rigorous methodology for aerodynamic closed-loop flow control. This approach enables more accurate control law designs for various flow control applications such as drag reduction, lift enhancement, separation control, and virtual aerodynamic shaping.

The approach also facilitates control law development for highly complex systems including vehicles that maneuver without external moving surfaces. Current methods are incapable of generating accurate and efficient control laws for high degree-of-freedom systems. This research will lead to more accurate computational analyses across a wider range of operating conditions than currently possible, yielding more robust control laws.

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Accomplishment

Directorate researchers successfully completed the first stages of developing a control law for aerodynamic flow control based directly on the fluid dynamics governing equations. This research applies advanced mathematics to computational fluid dynamics in a way never before used in engineering.

Traditionally, mathematically rigorous feedback control laws for unsteady aerodynamic problems are exceedingly difficult and expensive to calculate with existing methods because the number of unknowns in the problem is very large. Therefore, methods in the new approach were utilized to greatly reduce the computational cost required to determine the control law, while at the same time maintaining accuracy in the calculations. The first planned application of the technique is flow control near an open cavity like that found in the open weapons bay on a fighter aircraft.

Background

A control law is used to maintain system stability and achieve desired states. Currently, feedback control is applied to flow control on an ad-hoc basis. A model developed using experimental data and data collected from computational fluid dynamics is used to develop control laws.

Data can be collected for only a limited number of conditions, and the resulting control law may be inadequate under conditions for which data was not collected. As a result, situations requiring suppression or enhancement may be missed in the data collection process and, therefore, are not included in the formulation of the control law. The resulting control law would not be as effective as a control law directly created from the partial differential equation.

Air Vehicles
Emerging Technology

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (04-VA-01)